*T*media™

System Architecture Description

For Developers of VoIP and TDM Solutions

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Preface

About this Document

This document describes the TelcoBridges *T*media ™ telecom and media gateway platforms and Toolpack™ API by presenting and describing the key features that make this product line the preferred choice of VoIP and TDM solution developers. To further enhance the reader's understanding of the use of *T*media platforms, the architecture of a system based on the *T*media platform is described.

Intended Audience

This document is designed to introduce the *T*media platform to future and current TelcoBridges customers interested in learning more about the capabilities of *T*media and how it will satisfy and enhance their telecom solutions. As such, this document is recommended reading for anyone responsible or involved with strategic short- and long-term business planning decisions or people involved in telecom system design and development.

Contact Us

TelcoBridges is committed to continually improving the information contained in its documentation. We encourage all comments and appreciate in learning about whether our documentation is of use and pertinent to your needs.

Please do not hesitate to contact us:

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The TelcoBridges *T*media™ product line provides software and hardware platforms for you to develop a suite of telecom solutions. Helping you to simplify the development of your telecom solutions, TelcoBridges' *T*oolpack ™ provides a software framework that features a suite of ready-to-use *T*oolpack API, and specialized *T*oolpack applications, all of which are designed to enable you to shorten your development cycle and accelerate your time to market. Designed with today's telecom solutions in mind, TelcoBridges' *T*media hardware products respond with a highly advanced suite of telecom and media gateway platforms, consisting of the *T*media TMP6400, TMG3200, and TMS1600. Together, the *T*media software and hardware platforms contribute towards the successful deployment of your telecom solutions, such as:

- Media Gateways
- Prepaid/Postpaid
- Hosted VoIP Communications
- Unified Communications
- VoIP Trunking
- Ringback Tones
- IVR
- Conferencing

These solutions can be customized and integrated with IP, Mobile, TDM, WiMAX, and WiFI networks thanks to the flexibility, modularity, carrier-grade reliability, density and cost effectiveness of the *T*media product line.

Features

The TelcoBridges *T*media product line is designed to enable you to efficiently design your network solutions with the following built-in features:

- Flexibility
- High Density
- Modularity
- Scalability
- Carrier Grade
- Cost Effectiveness

Flexibility

- Choice of T1, E1, J1, DS3 and OC3/STM-1 TDM interfaces
- Use of SIP and multiple SS7, ISDN and CAS signaling variants
- Selection of signaling variants and T1, E1 or J1 operation on a per port basis
- Support for a wide selection of mixed voice codecs dynamically enabled on a per VoIP call basis
- Media-agnostic IVR capabilities (play, record, tone detection/generation, conferencing), dynamically used on TDM and VoIP channels
- Modular TDM, VoIP, IVR hardware to perfectly match interface and capacity requirements

TelcoBridges' *T*media telecom platforms provide the flexibility needed to interface with and deliver service on most telecom networks in existence today. Providing a wide variety of TDM and VoIP interfaces, signaling protocols, and voice processing functions, the *T*media platforms are used to build media gateway, switching, and value-added services solutions for modern networks.

*T*media platforms are controlled via TelcoBridges' *T*oolpack ™ API, a high-level event-driven C++ development environment providing unrestricted access to the full capability of the *T*media hardware. Using *T*oolpack API, developers of VoIP and TDM solutions can create custom telecom systems supporting a large number of applications such as: media gateway, prepaid/postpaid switching, personalized ringback tones, background music, voicemail, conferencing, unified communications, hosted IP-PBX, hosted IVR, and more.

The inherent flexibility of the *T*media platform allows solution providers to adapt their solutions to specific operator requirements.

High Density

- Up to 64 T1/E1/J1, or up to 3 DS3, or 1 OC3/STM-1, per *T*media unit and
- Complete set of wireline and wireless codecs supported with channel densities that go beyond 2048 channels
- Up to 2,048 universal VoIP channels , and
- Up to 2,048 IVR channels , and

All in a single 1U rackmount shelf.

*T*media platforms are the industry's highest density TDM and VoIP devices with up to 2,048 channels in a single 1U rack mountable device

The benefits of increased density are lower costs:

- Lower per port costs
- Lower maintenance costs
- Reduced space costs
- Lower capacity upgrade costs
- Lower system scalability costs
- Lower cooling costs

While *T*media platforms can be equipped with lower port counts of say 4 T1/E1/J1s, or 128 VoIP channels, they provide the ability to grow through the addition of modules to reach the high port densities required by services providers. Telecom systems built on *T*media platforms have the ability to scale beyond competitive offerings.

Modularity

VoIP

- Field upgradeable plug-in VoIP modules
- 128-2048 universal codecs
- Complete set of wireline and wireless codecs supported with channel densities that go beyond 2048 channels
- 128 ms echo cancellation on all channels

TDM

- Field upgradeable plug-in TDM module
  - 4-64 T1/E1/J1
  - 1-3 DS3 + 2 T1/E1/J1
  - 1 OC3/STM-1 + 2 T1/E1/J1

IVR

- Field upgradeable plug-in IVR module
- 128-2048 IVR channels

Since one size rarely fits all, TelcoBridges' *T*media telecom platforms and system architecture offers choices.

The *T*media units are modular 1U rackmount devices. Each *T*media unit offers TDM, VoIP and IVR capabilities using field-upgradeable hardware plug-in modules. The plug-in modules are easily added to the *T*media units in slots available inside.

The built-in hardware modularity allows solution developers to perfectly match the requirements of their customers, improving the cost-effectiveness of their solutions. TDM, VoIP and IVR plug-in modules may also be added in the field. Solution providers obtain a competitive edge by offering a more cost-effective upgrade path to their customers.

Scalability

TDM Interface Scalability

- From 4 x T1/E1/J1s to 8, 12, 16, 32, 48 and 64 ports through a combination of software and hardware field upgrades, or
- From 1 x DS3 to 2, and 3 DS3 ports through software field upgrades, or
- 1 x OC3/STM-1 with automatic protection switching

VoIP Scalability

- From 128 to 2,048 universal VoIP channels through the addition and combination of 128, 256, 384 and 512 VoIP channel field-installable plug-in modules

IVR Scalability

- From 128 to 2,048 IVR channels using a combination of software and hardware upgrades that can be performed in the field
- Field upgradeable plug-in IVR module

System Scalability

- Perfectly non-blocking up to 32,768 TDM, VoIP, or IVR channels in a single system, with or without redundancy, using the TMS1600 Switch in a mode of operation that is transparent to the controlling application.

The ability to gracefully scale telecom systems in order to fulfill increasing subscriber volume is the key to operator and solution provider successes. Ideally, port, capacity and content additions are performed transparently, ensuring limited downtime and seamless integration with OSS and management systems.

TelcoBridges' *T*media Platforms offer just that—the ability to transparently scale solutions up to 32,768 channels, and beyond—avoiding downtime and changes to higher-level control and management systems.

The *T*media system architecture is not limited by chassis or backplane bandwidth shortcomings. *T*media units are physically standalone devices controlled by an application server via Gigabit Ethernet links. System scalability is achieved through the addition of *T*media units which are preprovisioned to seamlessly integrate into an existing system.

Carrier Grade

- SS7 HA signaling—redundancy of both hardware and software
- Dual GigE VoIP traffic interfaces
- Perfectly non-blocking redundant switching architecture up to 32,768 TDM channels
- Live *T*media unit reconfigurations—no shutdown required
- Live *T*media unit and application server additions and removals
- Redundant application servers (active and standby)
- Redundant GigE control paths between the *T*media units and their application servers
- Constant system event logging and monitoring

Carrier-grade is a term used to describe telecom systems that meet high standards for availability, scalability, manageability and serviceability—high enough to satisfy the strict requirements of telecom operators for 99.999% or even 99.9999% system availability (i.e. less than 5 minutes of unscheduled downtime per year).

TelcoBridges' *T*media platforms and accompanying system architecture enable the development of carrier-grade telecom systems with no single point of failure to meet availability, scalability and serviceability requirements of operators.

*T*media platforms offer developers of VoIP and TDM solutions the industry's only telecom platform that truly enables them to bring to market a carrier-grade solution that can confidently be deployed by operators alongside the traditional big-iron systems.

*T*media platforms support key features that are essential to the development of carrier-grade telecom systems.

Cost Effectiveness

- Low per-port-cost
- Low upgrade cost
- Low application development cost
- Up to 75% lower operational costs

*T*media's cost-effectiveness advantages are multi-fold: lower port and capacity upgrade costs, lower application development costs, and lower operational costs. These advantages enhance the competitiveness of developers creating solutions based on *T*media.

The ability to configure the *T*media TDM, VoIP and IVR resources to precisely match end-user requirements allows developers to optimize hardware costs. The modularity of the *T*media platforms also allows solution providers to offer a more cost-effective upgrade path to their customers by simply adding hardware plug-ins to *T*media units instead of complete boards or additional units and servers to support higher port counts.

TelcoBridges provides developers with *T*oolpack API—a key component of *T*oolpack—that provides the system integrator with a high-level C++ application development environment that compresses the customer application development cycle by allowing software developers to concentrate on the core target—delivering services rather than having to deal with hardware. Using *T*oolpack API, which provides an event-driven application development environment and a large set of pre-developed sample applications, developers can reduce their development cycle, for example from 12 months to 12 days. A compressed development cycle provides significant competitive advantages related to time-to-market and overall solution cost-effectiveness.

TelcoBridges' *T*media platforms can reduce operational costs by as much as 75% through energy savings, reduced space usage, and fewer maintenance interventions. Each fully equipped *T*media unit consumes less than 100 Watts of AC or DC power under full traffic conditions—75% less than other platforms that require a larger chassis to house more hardware, additional power supplies and CPUs to reach a comparable port density. Significant savings are also realized on associated cooling and HVAC system capacities and power consumption. Plus, systems based on *T*media have a 50% smaller footprint, and practically eliminate the need for scheduled maintenance downtime, since most configurations can be performed dynamically without service interruptions.

Applications

The TelcoBridges *T*media product line enables you to easily implement the following applications:

- IVR
- Prepaid/Postpaid Switching
- Personal Ringback Tones
- Media Gateway
- Unified Communications
- Hosted VoIP Services

Interactive Voice Response (IVR) using *T*media TMP6400

- Support from 128-2048 IVR channels per TMP6400
- IVR features include: play, record, tone detection/generation/suppression, and conferencing
- Media agnostic IVR functionalities support TDM and VoIP
- Unlimited voice prompt, storage, and playback
- Standard interface to ASR and TTS engines

*T*media TMP6400 platforms enable highly flexible and completely customizable IVR solutions. Callers can be greeted by customized playback messages stored on the TB-StreamServer. TelcoBridges' TB-StreamServer application provides for the unlimited storage and playback of prompts and audio files required by large-scale applications. Each TB-StreamServer is capable of supporting in excess of 20,000 simultaneous audio channels and can interface with standard automatic speech recognition (ASR) or text to speech (TTS) engines.

No matter how large your IVR system and prompts storage and playback requirements are, the *T*media platform is designed to meet and scale with your business needs.

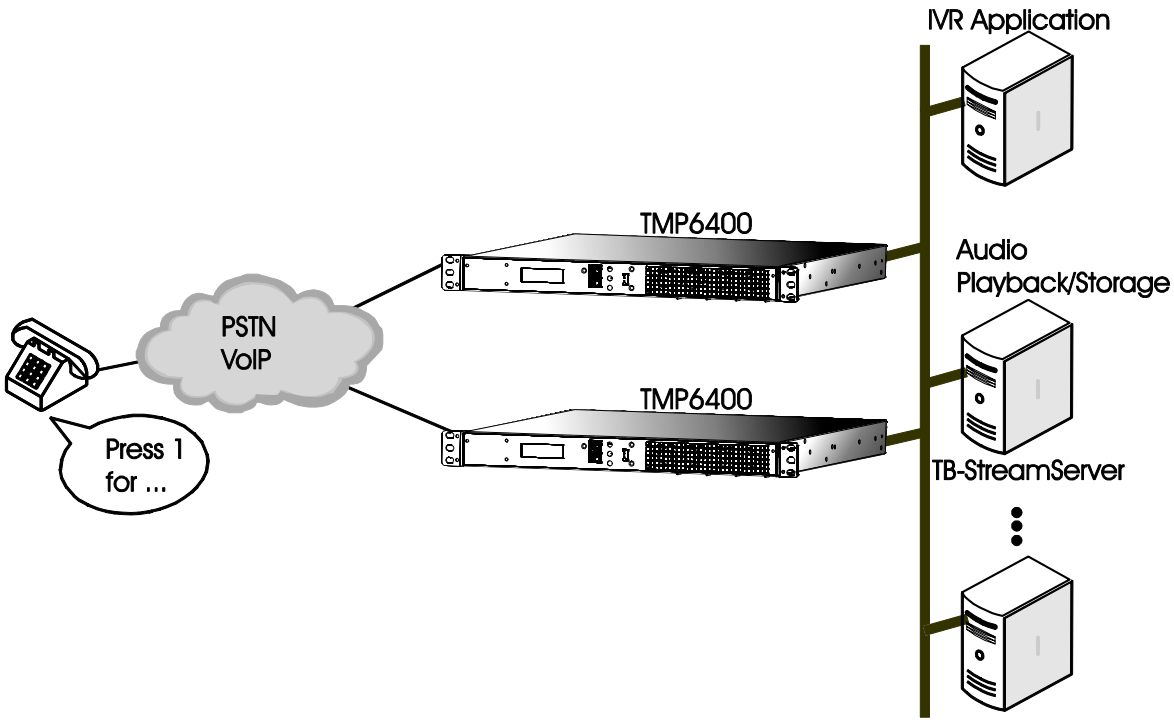


Figure 1.1: Interactive Voice Response Application

Prepaid/Postpaid Switching using *T*media TMP6400

- Non-blocking scalability up to 1,024 T1/E1/J1s, 48 DS3s, 16 OC3/STM-1s, or any mix of these interfaces
- Support for SIP and multiple SS7, ISDN, and CAS signaling stacks and variants
- Live per interface and per network signaling protocol configuration (type and variant)
- Seamless integration of VoIP
- Dynamic VoIP codec selection from a complete set of wireline and wireless codecs
- G.168 128 ms echo cancellation on all VoIP channels (independent of codec resources)
- Modular IVR supporting play, record, tone detection/generation, and conferencing
- Unlimited audio prompt storage and playback for IVR functions

Whether entirely based on TDM interfaces, entirely on VoIP, or supporting a mix of VoIP and TDM connections, the *T*media TMP6400 is the ideal platform for developers creating prepaid, postpaid and least-cost routing solutions. In such applications, where the switching platform connects to multiple networks with different signaling protocols and variants, it is the key to have the flexibility to dynamically and simultaneously support multiple signaling stacks and variants. Furthermore, the ability to scale a prepaid switch without restrictions or having to partition its ports may have a direct impact on the success or failure of the operator.

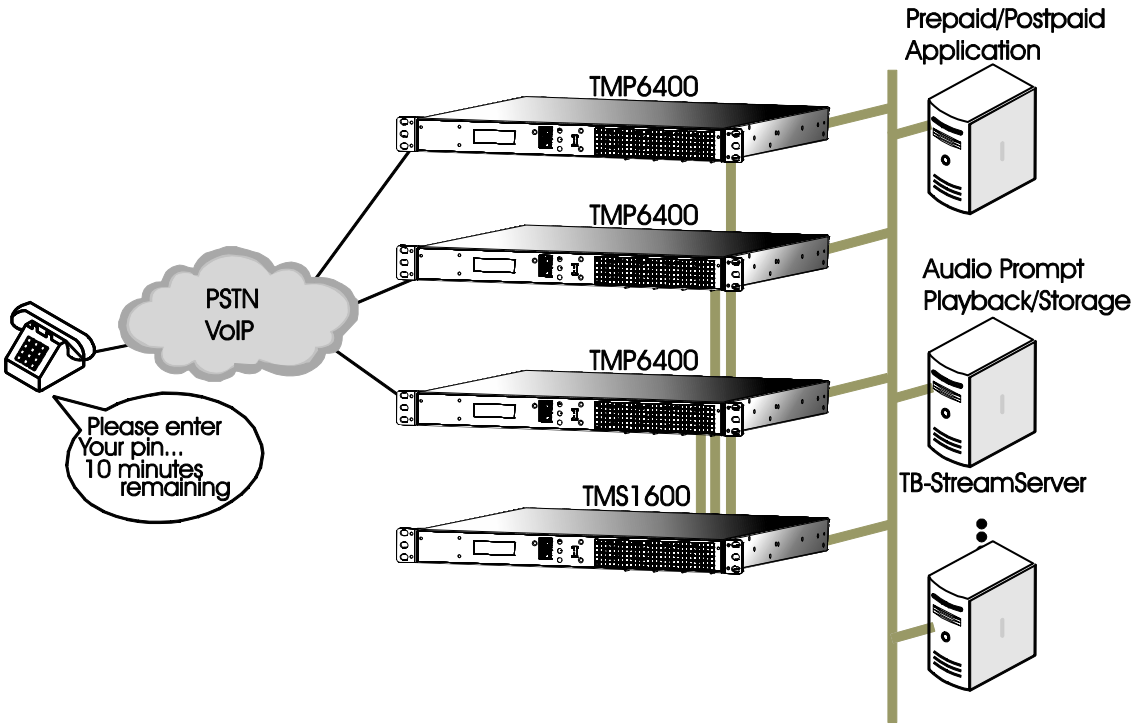


Figure 1.2: Prepaid/Postpaid Switching Application

Personalized Ringback Tones (PRBT) using *T*media TMP6400

- Simultaneous delivery of 2,048 ringback tones per TMP6400 unit
- Unlimited scalability through the addition of TMP6400 units
- Up to 64 T1/E1/J1, 3 DS3, or 1 OC3/STM-1 per TMP6400 unit for connection to the network
- Integrates with an NGN architecture where TMP6400 units can stream the ringback tone content over IP (up to 2,048 universal VoIP channels per unit)
- High-performance SS7 signaling supporting more than 1,000 calls per second per *T*media unit
- High-performance audio streaming supporting more than 20,000 simultaneous audio streams per TB-StreamServer
- Unlimited content storage and playback using multiple TB-StreamServers

*T*media TMP6400 platforms enable the development of highly-competitive Personal Ringback Tone solutions. Replacing the standard "ring-ring" tone heard by callers of mobile subscribers with music or personalized greetings, voice messages, or custom sound bites, requires the ability to store and playback a large amount of content, support a high rate of call setups and teardowns, and a large number of ports for the simultaneous delivery of ringback tones to callers. TelcoBridges' *T*media TMP6400 platform enables the creation of the world's largest PRBT solutions. TelcoBridges' unique system architecture eliminates all scalability limitations and system management issues encountered with competitive offerings.

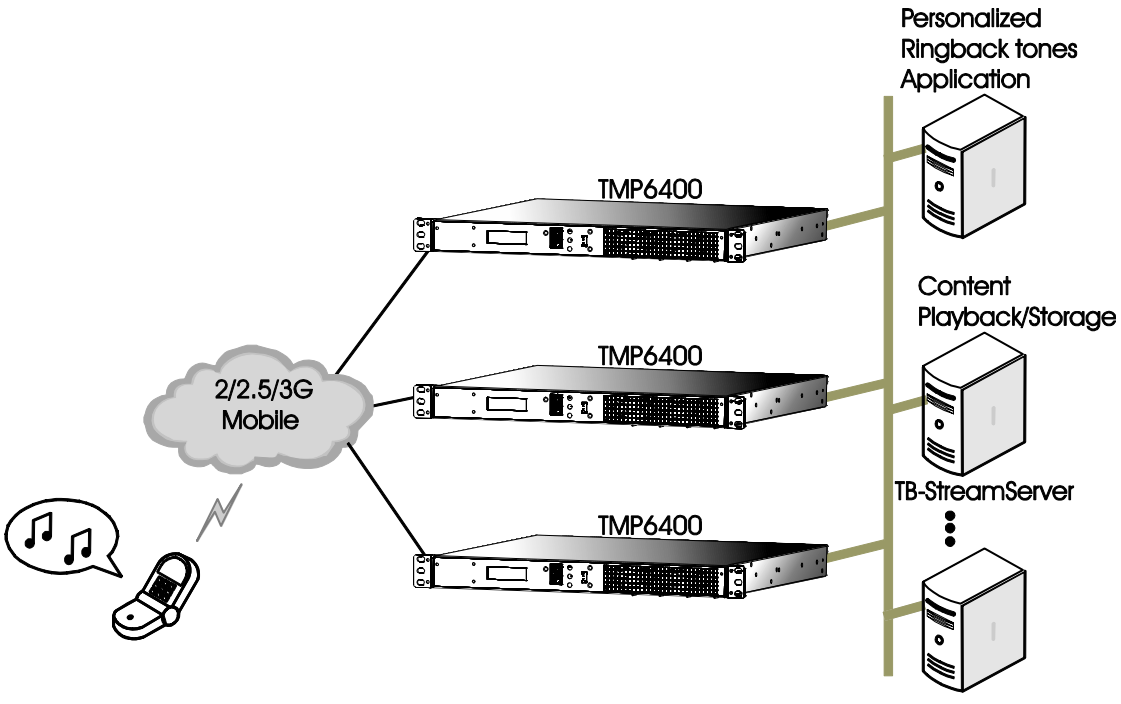


Figure 1.3: Personalized Ringback Tones Application

Media Gateway using *T*media TMG3200

- On-board Linux application Freescale 400 MHz host CPU, with 512 MB RAM and 2 GB flash disk —eliminates the need for an external application server and provides developers with the ability to customize their solutions to create their own black box.
- Up to 2,048 universal VoIP channels (i.e. G.711, G.723.1, G.726, G.729ab) in a single 1U rackmount unit
- G.168 128ms echo cancellation on all channels simultaneously (independent of codec resources)
- Modular and field-upgradeable hardware from 128 to 2,048 universal VoIP channels
- Simultaneous support for SS7, ISDN, CAS, and SIP signaling
- Support for up to 64 T1/E1/J1 interfaces, or up to 3 DS3s, or 1 OC3/STM-1
- Dual GigE VoIP interfaces
- Optional plug-in IVR module supporting play, record, tone detection/generation, and conferencing (up to 2,048 simultaneous channels)

Using the *T*media TMG3200 to bridge TDM and VoIP networks provides a scalable platform which can be configured to achieve high port densities and also enable other functions, such as IVR and conferencing for example. In service provider networks, media gateways need to have the ability to simultaneously support multiple signaling protocols, support a wide array of VoIP codecs on a large number of channels, and offer the flexibility to customize their operation such that their integration with existing networks is seamless. TelcoBridges' TMG3200 is a unique offering, in that it is equipped with an on-board Linux application host CPU that uses *T*oolpack to run custom media gateway applications that perfectly fit the needs of various implementations.

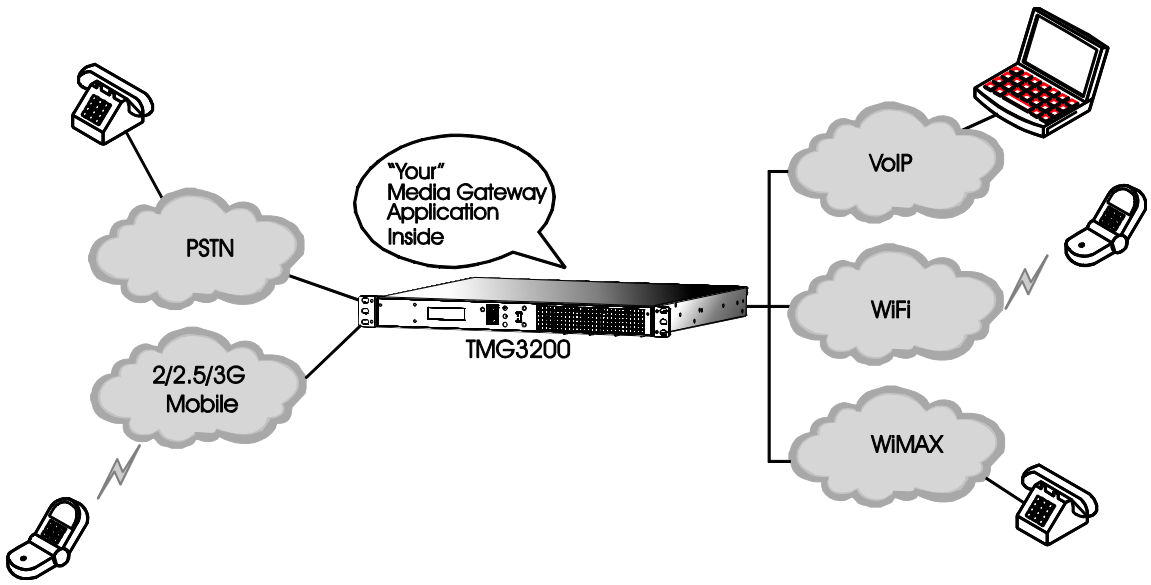


Figure 1.4: Media Gateway Application

Unified Communications using *T*media TMP6400

- Support for multiple signaling protocols: SIP, SS7 (SS7 layers: ISUP, TCAP, SCCP, MTP3, MTP2), ISDN and variants with access to low-level information
- Enables SMS sending and receiving via TCAP protocol
- Flexibility to connect to any TDM network, using T1/E1/J1, DS3, or OC3/STM-1 interfaces
- Support for a wide selection of voice codecs and any-to-any real-time transcoding enabling communications between wireline, wireless and VoIP networks
- Support for SIP, enables support for SIP-T and access to session description protocol fields (SDPs) and header fields
- Ability to store audio from any media in standard formats
- Support for real time automatic speech recognition (ASR) and Text to Speech (TTS)

Unified communications is the integration of different telecommunications networks, media, even devices, into a single environment which simplifies and enhances the user's experience. TelcoBridges' *T*media platforms have the ability to enable unified communications applications by providing access to the media, whether it is landline voice, mobile voice, fax, SMS, voicemail, instant messaging, music, etc. The *T*media platforms access these different media types on TDM and VoIP networks and have the ability to process them for recording, playback, storage, transcoding, and switching. *T*media platforms provide the enabling technologies for developers to build unified communications solutions.

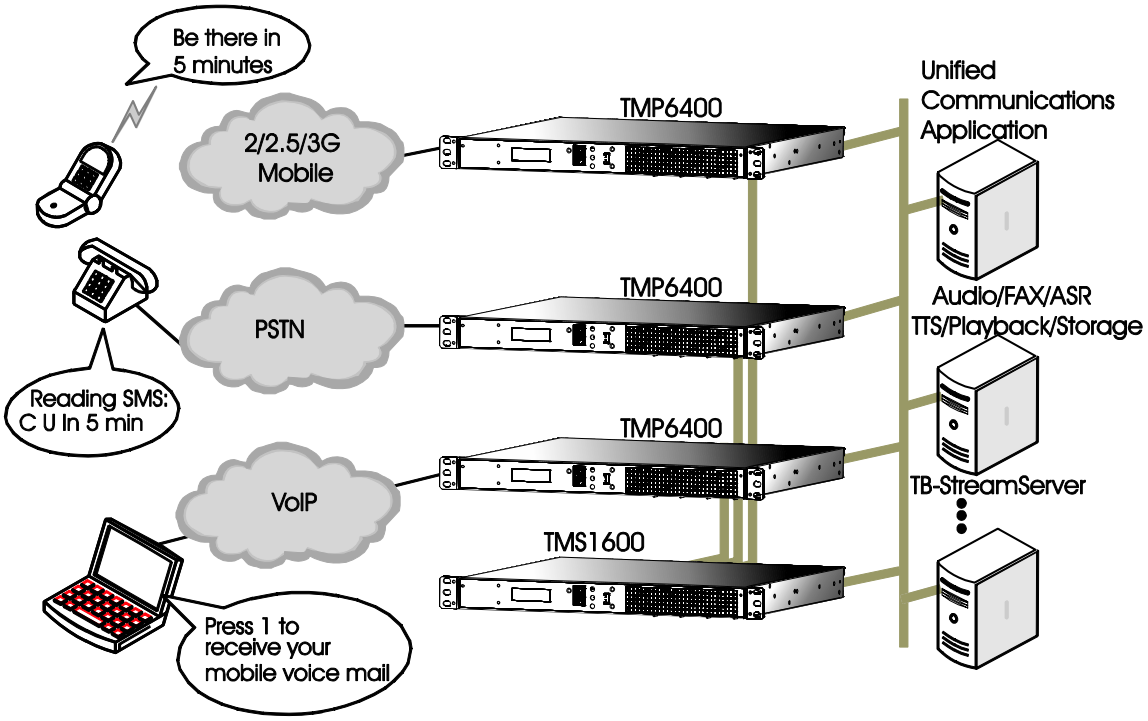


Figure 1.5 Unified Communications Application

Hosted VoIP Services using *T*media TMG3200

- Up to 2,048 universal VoIP channels per TMG3200
- Dynamic selection of VoIP codec on a call-by-call basis
- Complete set of wireline and wireless codecs with any-to-any transcoding
- Support for in-band, RFC2833 and SIP INFO tone transport
- G.168 128ms echo cancellation simultaneously on all channels, independent of codec resources
- Support for SIP signaling with access to session description protocol (SDP) fields
- Optional IVR features for play, record, tone detection, generation, and conferencing
- Optional TDM interfaces with SS7, ISDN, and CAS signaling

The increased deployment and use of VoIP simplifies the infrastructure needed to deliver hosted communications services, that is the delivery of telecom services, such as: IVR, voicemail, conferencing, IP-PBX, etc. from a central location managed by a service provider, rather than using telecom equipment installed on-site and managed locally. The use of VoIP facilitates the delivery of hosted services through a simplified access network and readily available VoIP devices, such as: IP phones, soft-phone clients, analog telephone adaptors, and carrier-grade VoIP platform, such as the TMG3200. Using the TMG3200, a service provider can host a wide variety of services to a large number of subscribers.

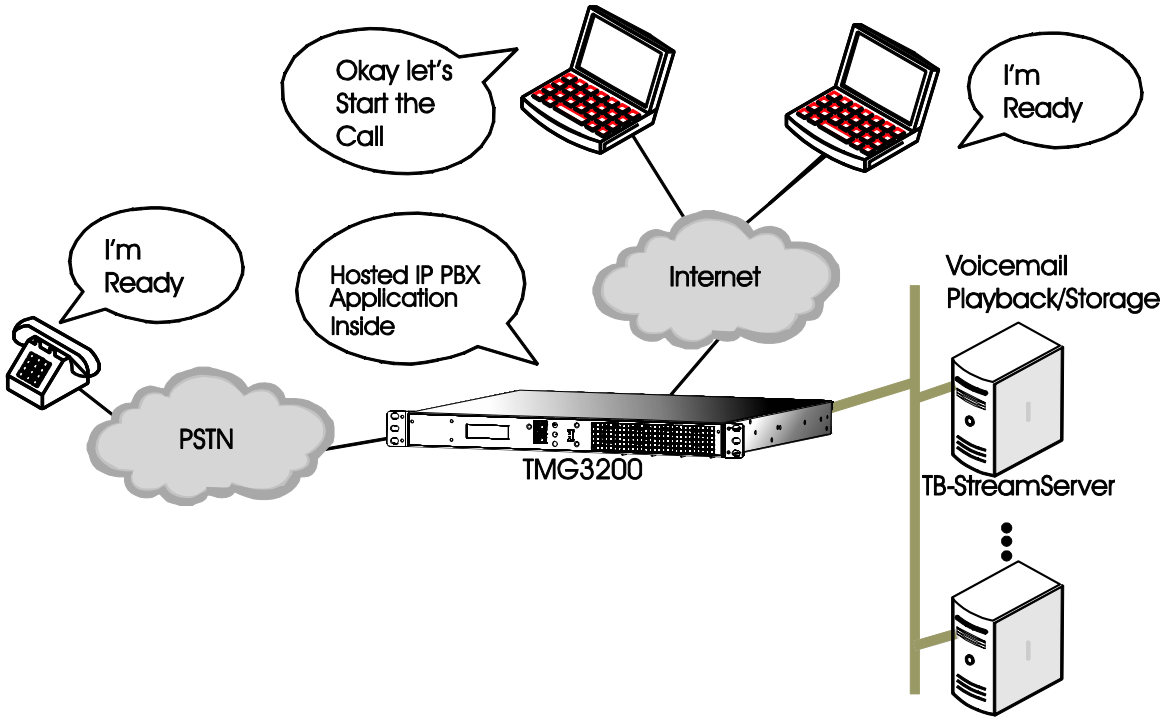


Figure 1.6: Hosted VoIP Application

1.3 *T*media™ Hardware Building Blocks

The TelcoBridges *T*media product line consists of three key modular building blocks to bring your networking solutions to fruition.

TMP6400 Telecom Platform

The *T*media TMP6400 series is a flexible telecom platform for developers building VoIP and TDM solutions, such as: prepaid/postpaid switching, ringback tones, conferencing, IVR, voicemail, and unified communications.

TMG3200 Media Gateway Platform

The *T*media TMG3200 series is a media gateway platform enabling developers to create, in addition to TDM solutions, innovative VoIP solutions. The TMG3200 integrates an on-board application-ready Linux Host to run your custom media gateway applications.

TMS1600 Switch

The *T*media TMS1600 Switch is a key scalability component to allow developers to build large-scale carrier-grade VoIP and TDM solutions. The TMS1600 Switch provides the means by which a combination of TMP6400 units can be interconnected to create a 32,768 perfectly non-blocking system, supported transparently by *T*oolpack.

*T*media Unit

1.4 *T*media Software Building Blocks

TelcoBridges *T*media software platform is supported by modular and customizable *T*oolpack applications for developers to efficiently design carrier-grade solutions.

*T*oolpack ™ API

TelcoBridges *T*oolpack API, consisting of a series of applications and C++ classes, simplifies and accelerates the development cycle because it features a pre-developed set of C++ application building blocks which aid the developer in creating carrier-grade solutions. Some key components:

- Source code provided to aid in application development, for example:
  - Call routing
  - IVR
  - Ringback tones
  - Media gateway
  - and more
- Optional Web-based OAM&P GUI for: provisioning, reporting of status, and state management
- Pre-integrated HA and redundancy from hardware up to the application level
- Unified SIP, SS7, and ISDN
- Seamless VoIP, TDM, and IVR

With the concept of high availability tied into every facet of the *T*media system design, *T*oolpack transparently handles:

Signaling

- SIP, SS7, ISDN, and CAS

Controls hardware resources and adapts media formats

- VoIP: IP,UDP,RTP, RTCP
- TDM:T1/E1/J1, DS3, OC3/STM-1

Controls and shares IVR and VoIP transcoding resources across the entire system

- IVR: play, record, tone detection and generation, and conferencing
- VoIP: complete set of codecs, G.168-128 ms on all channels, T.38, RFC2833

Carrier Grade

- Non-blocking scalability up to 32,768 channels
- Hardware and software redundancy

Chapter 2 System Architecture

The TelcoBridges *T*media platform is designed upon solid carrier-grade architecture. Each *T*media building block, whether it is TelcoBridges' *T*oolpack™, the TMP6400, TMG3200, or the TMS1600 Switch, is supported by a distributed and redundant application and server architecture, redundant power, dual GigE links to the VoIP network, and dual GigE links to the controlling application.

The *T*media platform is geared to provide consistent and reliable control of telecom and media gateway platforms practically eliminating service interruptions.

2.1 Application and TB-StreamServer: Distributed Load Sharing

The architecture of *T*oolpack™ allows for its elements to be distributed across multiple servers in order to even out the processor load on any given computer. In addition, to ensure recovery from application or server failure, all *T*oolpack applications are designed to reside as duplicate elements on redundant machines. Even distribution of workload and redundant backup is available for:

- Customer and TelcoBridges *T*oolpack C++ applications
- System and HA Manager application
- *T*oolpack Engine Application
- OAM&P application
- TB-StreamServer application

Application Servers

The application server runs the customer and *T*oolpack applications. These applications will run on Intel/SPARC Solaris, Linux, and Windows machines. In order to guarantee that connectivity is always maintained between application servers and the *T*media units, servers communicate across dual redundant GigE Ethernet links. Furthermore, to guarantee efficient operation, components of the application server software can be duplicated and/or distributed across more than one server in order to support load sharing as well as continued operations should a server fail.

Note: Since the *T*media TMP6400, TMG3200, and TMS1600 carry out the major portion of the processing work, less of a load is placed on the application servers, thereby allowing, in most cases, for a single server to run *T*oolpack and the controlling application. In fact, in the case of the TMG3200, *T*oolpack and the controlling application can be run inside the unit hosted by the Linux application eliminating an external server.

TB-StreamServers

The TB-StreamServers provide the data storage and streaming of audio and fax for applications such as personalized ringback tones, voice messaging, IVR, and fax storage. Similar to the application server, the TB-StreamServer is designed to operate on independent Ethernet links and to allow for the duplication and/or distribution of TB-StreamServer data across multiple TB-StreamServers in order to support load sharing, expand scalability, and to safeguard against hardware failures.

Application Distribution Scenarios

Usually, the decision to distribute customer applications and *T*oolpack applications across several machines is made in order to guarantee an even load sharing across machines; however, the *T*oolpack architecture allows for you to decide upon the distribution scenario that best suits your needs. A few likely scenarios are presented:

- One *T*oolpack application server and one TB-StreamServer with integrated fax server
- One *T*oolpack application server and one TB-StreamServer with external fax server
- Two *T*oolpack application servers and two TB-StreamServers with external fax servers

***T*oolpack Application Server, TB-StreamServer with Integrated Fax Server**

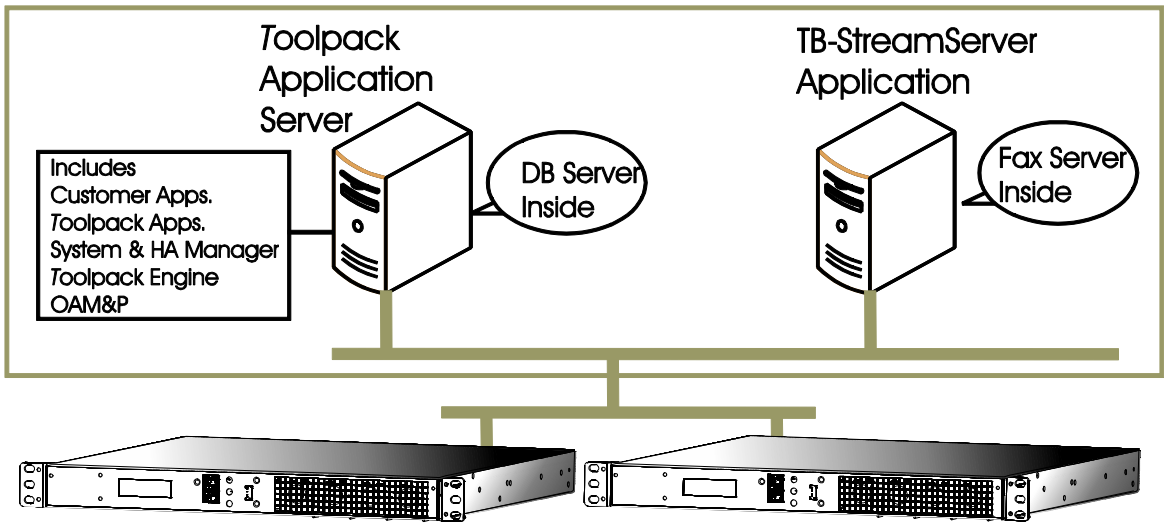


Figure 2.1: Toolpack Application Server and One TB-StreamServer

Toolpack Application Server with External Database Server, TB-StreamServer with Integrated Fax Server

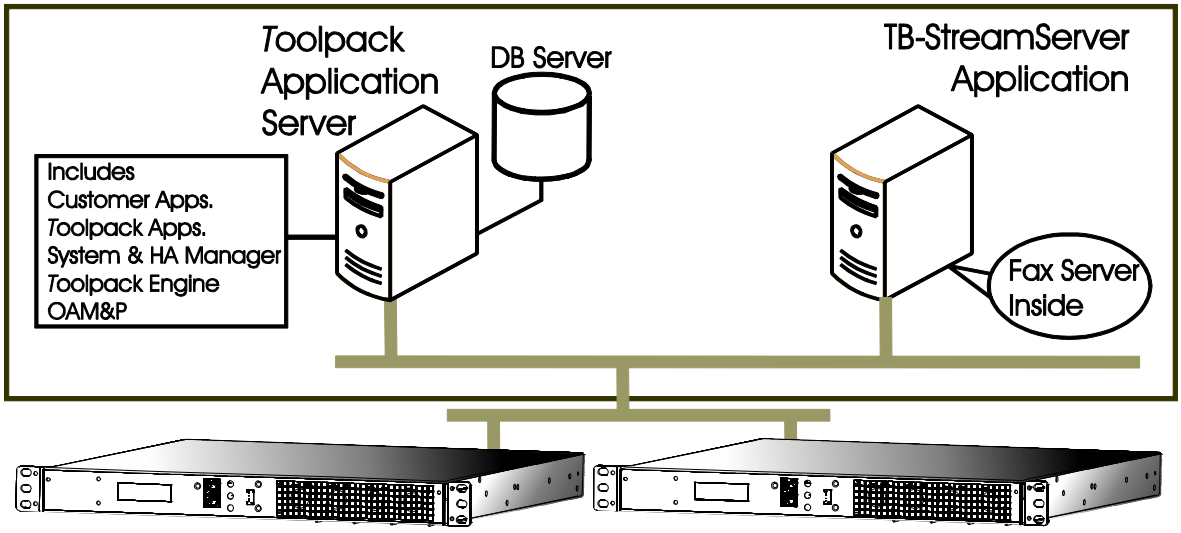


Figure 2.2: Toolpack Server with External Database Server

Toolpack Application Server and Customer Application Servers with External Database, TB-StreamServer with External Fax Server

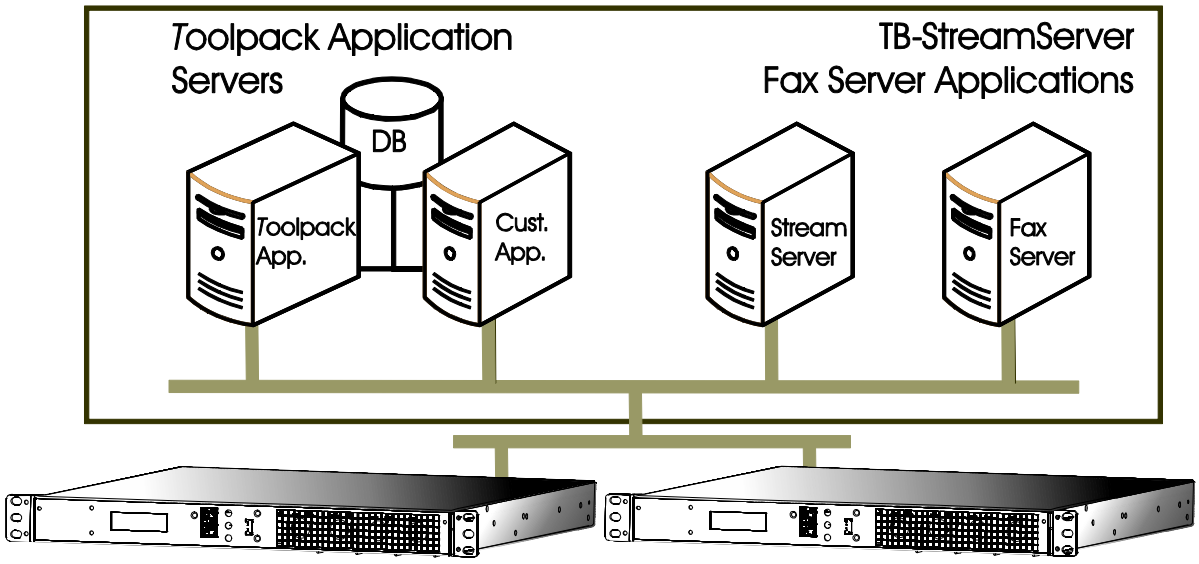


Figure 2.3 Toolpack and Customer Application Servers, TB-StreamServer with Ext. Fax Server

2.2 *T*media System Architecture Redundancy

A keystone concept of paramount importance in the design of the *T*media carrier-grade architecture is that no single failure should result in the suspension of services. Redundant application server control links and redundant GigE VoIP network links as well as redundant power supplies are all features designed to deliver reliable and solid network services.

*T*oolpack Application and TB-StreamServer Redundancy

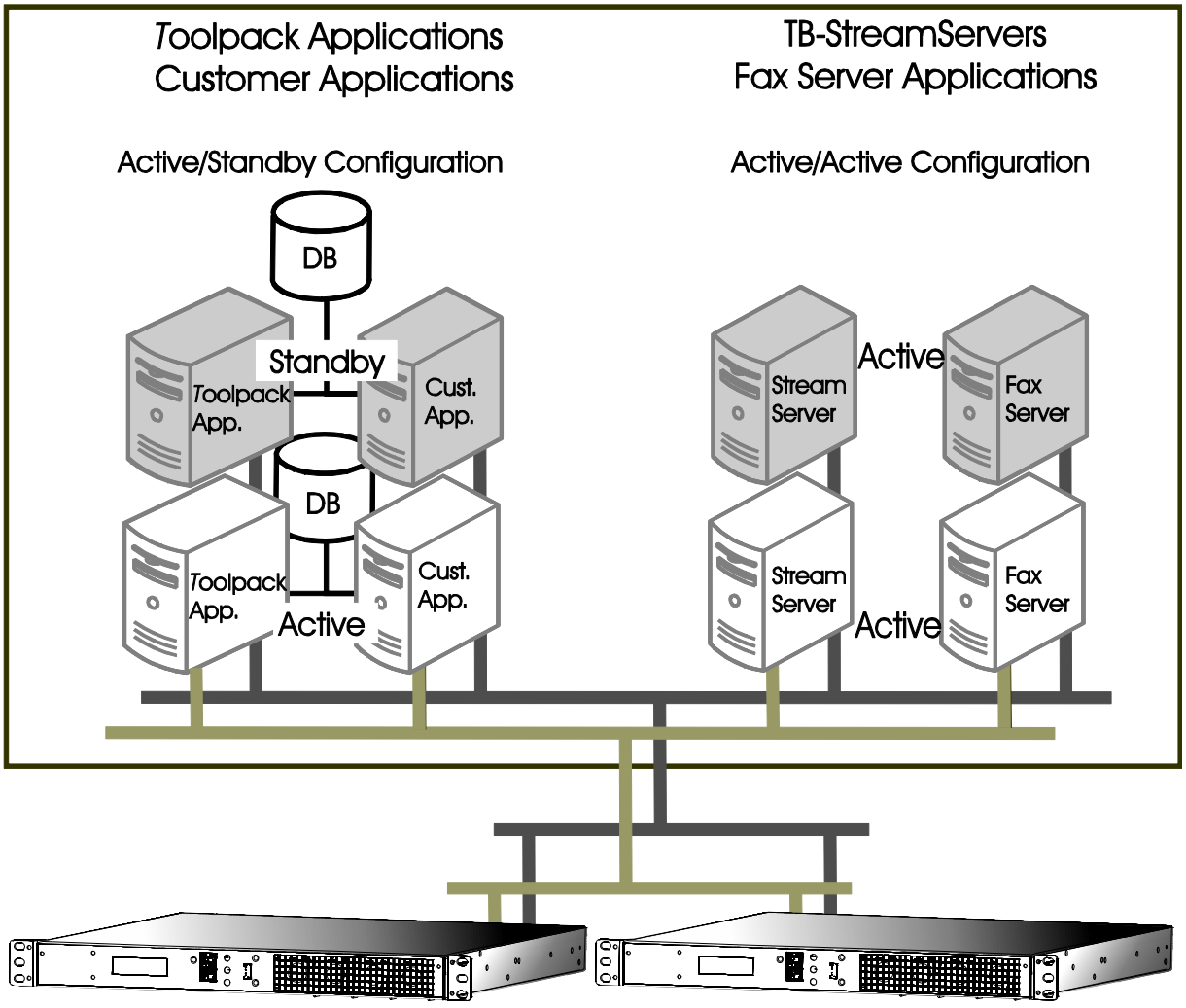


Figure 2.2: Active/Standby and Active/Active Server Architecture

Redundant GigE *T*media Control Links

The application and TB-StreamServers can be configured to operate on redundant network links so that they can communicate without interruption with the TMP6400, TMG3200, and TMS1600 units. Each one of the *T*media units is furnished with dual GigE links expressly provided for redundant control by the application servers. Both links are operational with one link active and the other in a hot standby mode. The switchover itself is an automatic process controlled transparently by the *T*oolpack applications.

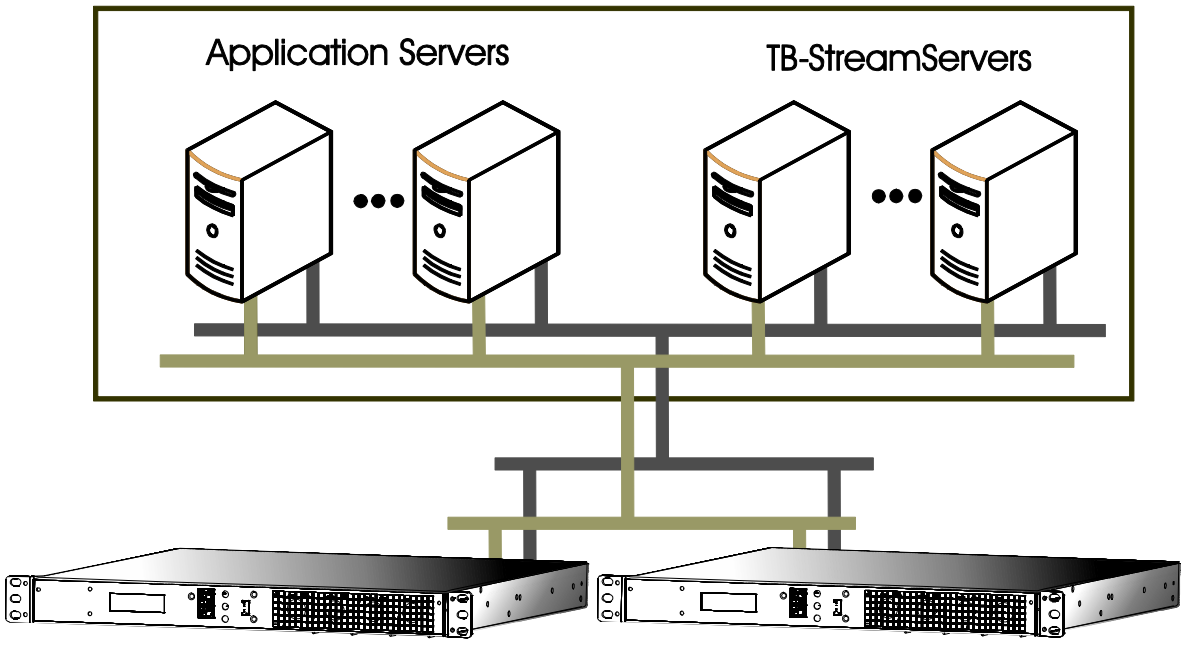


Figure 2.3: Redundant Control Links Architecture

Dual GigE VoIP Network Links

The TMP6400 and TMG3200 feature, as a standard option, dual GigE ports for connection to different VoIP networks. Should one of the IP networks fail, the *T*media unit can continue to handle VoIP traffic via the alternate network.

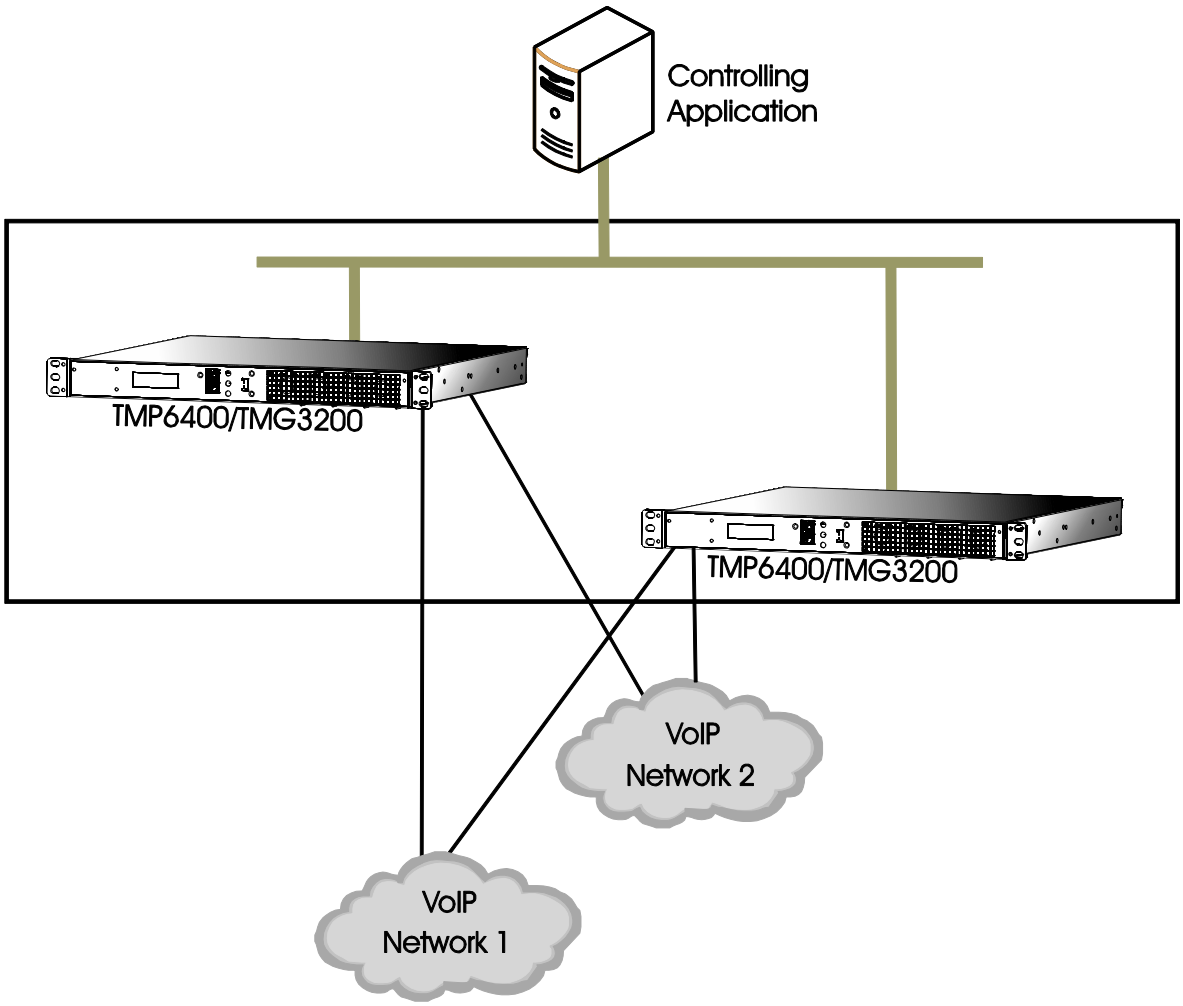


Figure 2.4: Dual GigE VoIP Network Links Architecture

Redundant Power Sources

The *T*media TMP6400, TMG3200, and TMS1600 units support either AC or DC redundant power supplies. The redundant power supply option uses an external redundant power-pack unit supporting dual AC or DC power feeds that in turn provide power to the redundant power supplies inside the unit. The redundant power pack provides power to a single *T*media unit via a multi-conductor power cable. The failure of an AC or DC power source or the failure of one of the power supplies inside the redundant power pack will have no effect on the *T*media unit; furthermore, no loss of service will occur.

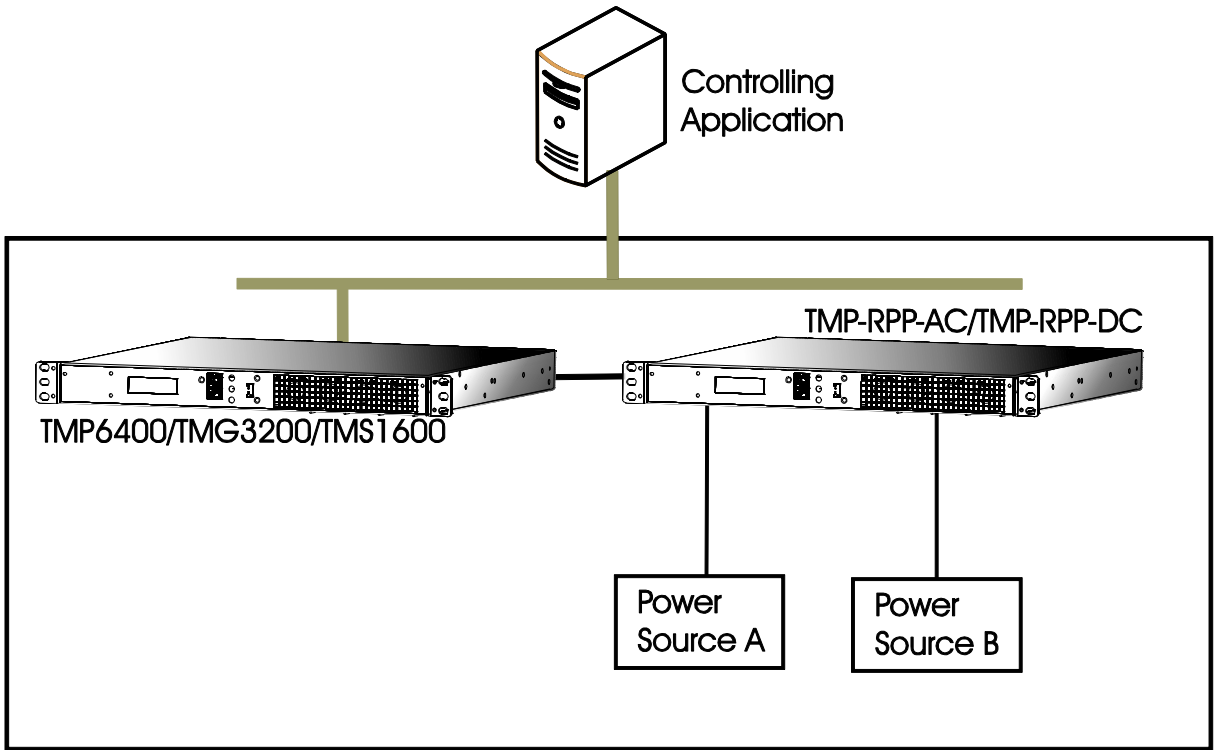


Figure 2.5: Redundant Power Sources Architecture

2.3 Highly Scalable Architecture for Carrier-Grade Solutions

The modular design of the *T*media TMP6400 and TMG3200 units provides up to 64 T1/E1/J1, 3 DS3, or 1 OC3/STM-1 for 2048 voice channels, and more than 2048 universal codec VoIP connections in a single unit. As your network continues to grow, so may your capacity needs. With the *T*media system architecture, you are not confined to the limits of a single unit. In fact, using the TMS1600 Switch, a combination of up to 16 TMP6400s can be used and managed as a single system, effectively scaling to provide up to 32,768 non-blocking channels without any modifications needed to the controlling application. Due to the dual-star architecture of the *T*media platform, the TMS1600 adds automatic system redundancy.

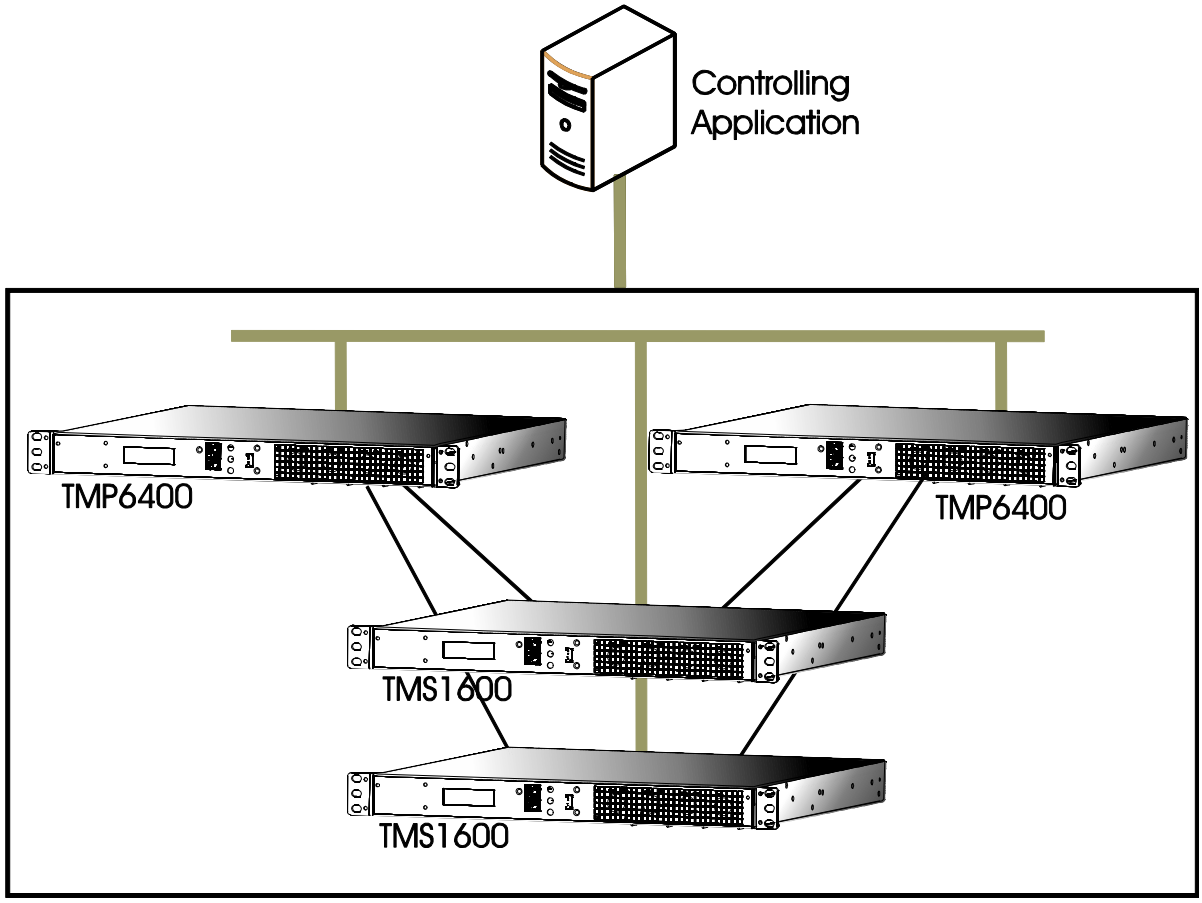


Figure 2.6: Scalable Architecture

2.4 Implementation of High Availability

The *T*media system architecture is designed from the ground up with the concept of high availability in mind. This means that a telecom system based on *T*media can achieve carrier-grade 99.999% or even 99.9999% target availability requirements. High availability has been designed into the *T*media framework specifically with the following in mind:

- Active/Standby *T*media Control Links
- Active/Standby *T*oolpack Engine
- Active/Standby Customer Applications and TelcoBridges software modules
- Active/Standby *T*oolpack Engine Interface
- Active/Standby System and HA Manager
- Active/Standby Databases
- Active/Standby OAM&P
- Active/Active TB-StreamServer
- Signaling protection
- Active/Standby *T*media TMS1600 Switch
- Automated call state resynchronization and coherency check, integrated into *T*oolpack API enabling the rapid rebuild of the standby application

Non-Blocking Channels

The architecture of the *T*media platform is designed to enable the creation of large-scale non-blocking switching systems. A fully-configured system based on TelcoBridges' system architecture can seamlessly scale from a few ports to create a large telecom system supporting up to 1,024 T1/E1/J1s, or up to 48 DS3s, or up to 16 OC3/STM-1s, or any mix of these interfaces up to 32,768 non-blocking voice channels. For VoIP communications, 2048 channels of universal codecs are supported by each *T*media unit with support for an unlimited number of units in pure VoIP systems.

SS7 Signaling Protection

High availability telecom systems usually require multiple redundant signaling paths. Solutions developed using *T*media platforms and system architecture inherently support signaling protection whereby one signaling stack running on one *T*media unit can be backed up and load shared on other *T*media units that are part of the same system. This signaling protection feature is automatically implemented by the System and HA Manager application for SS7 signaling.

Active/Standby *T*media TMS1600 Switch

The *T*media TMS1600 Switch is used to transfer voice channels between TMP6400s supporting the interconnection of up to 16 *T*media units. This provides for a low-delay connection scheme. The *T*media system architecture supports a dual-star interconnection where each TMP6400 is connected to two redundant TMS1600 units. In the unlikely circumstance that a *T*media TMS1600 Switch fails, the System and HA Manager application will switch all functionality from the active TMS1600 to the standby TMS1600. All this is done automatically and transparently to the controlling application.

Active/Standby *T*media Control Links

Each *T*media unit is designed with two GigE control links to the controlling application. With one port serving as active and one port serving as standby, the *T*media unit will never lose communication with the controlling application. In the event that the active control path was to fail, the alternate control path is selected in a manner transparent to the *T*media platform.

Active and Standby *T*oolpack Applications

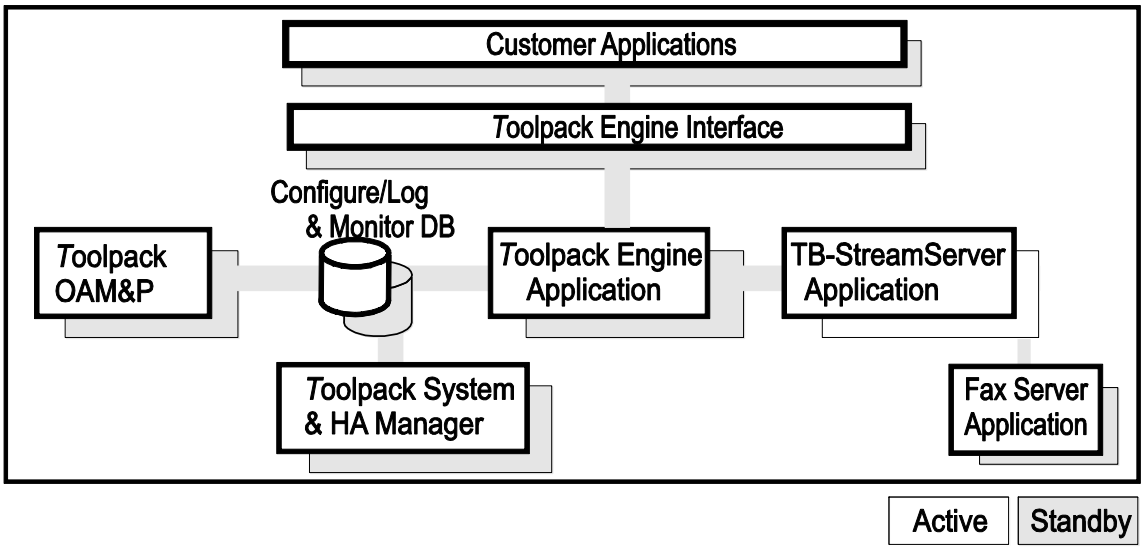


Figure 2.7 Toolpack Applications

Active/Standby System and HA Manager

The System and HA Manager application, with all of its functionality, can reside on separate servers for redundancy purposes. Each application—whether it is designated as active or standby—is always up-to-date and synchronized with current system status; furthermore, the

System and HA Manager application is self-monitored and, when required, will switch itself from its active to its standby application.

Active/Standby OAM&P

The *T*oolpack OAM&P application supports an active/standby configuration. By running the active and standby applications on separate servers, the system is thereby protected from failure of the OAM&P application. As information in the network changes, both applications are updated simultaneously. If a failure occurs, the standby application assumes control without any mismatch of information.

Active/Active TB-StreamServer

The TB-StreamServer application can reside on two or more separate machines for load sharing and redundancy purposes. For each play or record channel, the *T*oolpack Engine selects one of the active TB-StreamServers to execute the command, depending on the availability of files and the instantaneous load of the TB-StreamServers. In this active/active mode, all the play and record media is transmitted by the active TB-StreamServers. If an active TB-StreamServer application, server, or communication link were to fail, the current streaming of media would stop and the customer application would be notified. At the same time, another TB-StreamServer is assigned to take over the task.

Active/Standby *T*oolpack Engine and Interface

The *T*oolpack Engine application is the core element of *T*oolpack. This critical element will not fail because of a failure recovery plan in place. The *T*oolpack Engine application can reside on two servers so that the failure of the active server or application will not interrupt network operations. Transparently and without any outside intervention, the *T*oolpack Engine Interface switches all control of the *T*oolpack Engine application over to its standby counterpart. Much like the *T*oolpack Engine, redundancy has been built into the *T*oolpack Engine Interface so that this application too can reside on separate machines. Due to this unique design architecture, there is no need for an active state synchronization between the *T*oolpack Engines; the *T*oolpack Engine can entirely regenerate its data from the states and resources residing on each *T*media unit.

Active/Standby Customer Application

The customer application supports an active/standby configuration. By running the active and standby applications on separate servers, the system is protected from loss of data. If the active customer application fails, the standby customer application takes over and is uploaded with the current call activity from the *T*oolpack engine. The customer application can then determine if it can keep the calls active, or if any of the calls should be terminated due to missing information.

Active/Standby Databases

As with the *T*oolpack applications, all of the *T*oolpack databases can be configured to be redundant. The failure of one database will not cause any data loss to the system because the standby is always up-to-date with current system information.

Chapter 3 *T*media Hardware Platform

The *T*media hardware platform is designed as modular building blocks and comprises:

- *T*media™ TMP6400 Telecom Platform
- *T*media™ TMG3200 Media Gateway Platform
- *T*media™ TMS1600 Switch

3.1 General Description

TMP6400 Telecom Platform

The *T*media product line features the TMP6400, which is an all-purpose telecom platform. It provides modular VoIP, IVR, and TDM plug-in hardware in carrier-grade architecture all in a 1U form factor.

Optional VoIP plug-in modules provide from 128 to 2,048 universal VoIP channels. All channels have access to a complete set of VoIP codecs.

Optional IVR plug-in modules provide 128 to 2,048 channels. IVR channels are used to play, record audio, detect, generate, and suppress tones as well as conferencing for up to 132 talkers and an unlimited amount of listeners per conference.

Optional TDM plug-in modules provide a choice of interfaces:

- 4, 8, 12, 16, 32, 48, 64 T1/E1/J1 ports, or
- 1, 2, or 3 DS3 interfaces with 2 T1/E1/J1 ports for BITS synchronization or signaling, or
- 1 OC3/STM-1 with automatic protection switching, with 2 T1/E1/J1 for BITS synchronization or signaling

TMG3200 Media Gateway Platform

Designed specifically for media gateway applications, the *T*media TMG3200 is a pre-integrated media gateway platform that developers can use to create innovative VoIP solutions in a 1U form factor. In addition to the optional plug-in VoIP, IVR, and TDM modules, the TMG3200 provides an on-board Linux Freescale 400 MHz CPU with 512 MB RAM and 4 GB flash disk, thereby eliminating the need for external application and TB-StreamServers.

TMS1600 Switch

Designed to scale your system beyond a single *T*media TMP6400, a single *T*media TMS1600 Switch interconnects up to 16 TMP6400 units to create a powerful and cost effective large-scale system.

The TMS1600 Switch provides any-to-any timeslot switching between 1,024 T1/E1/J1s, 48 DS3s, or 16 OC3/STM-1s. Together, this provides for 32,768 perfectly non-blocking channels. Furthermore, because the TMS1600 is TDM based it provides a switching latency of less than 512 microseconds.

3.2 Front View

Designed for ease of access and the viewing of status indications, the *T*media TMP6400, TMG3200, and TMS1600 Switch all feature the following:

- Status Window
- 3 management ports
  - 10/100/1000Base-T (RJ45F)
  - RS-232 serial console (RJ45F)
  - USB 2.0
- Power LED
- Reset Switch
- Functions Switch

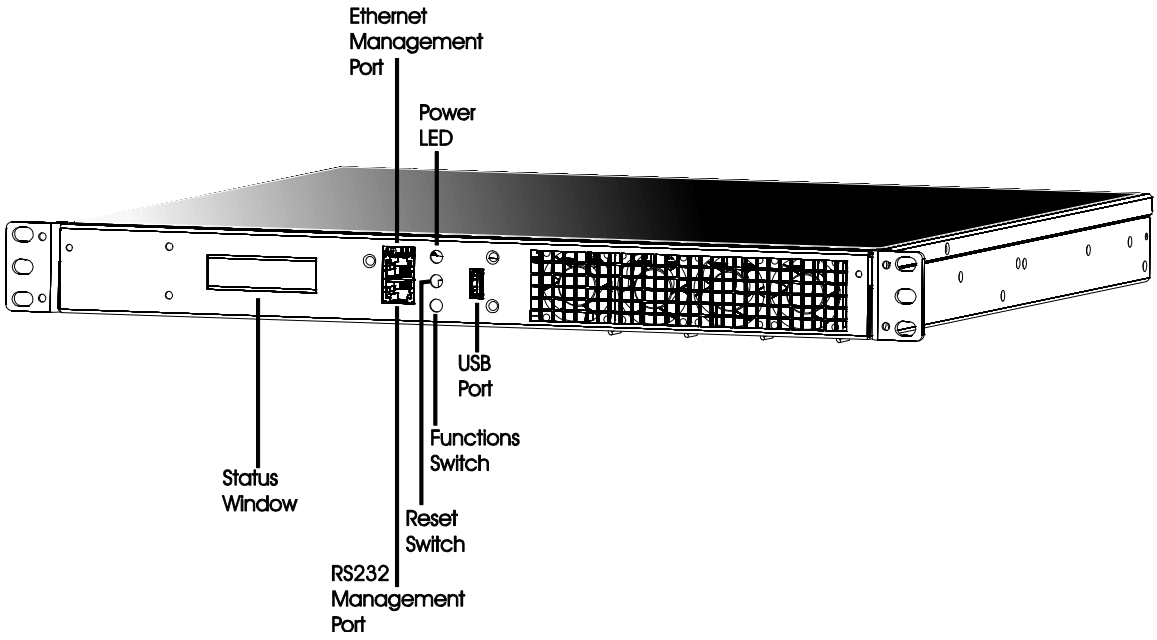


Figure 3.1: *T*media Unit Front View

Status Window

The status window is a graphical 122X32 pixel display. Normally, the window is configured to display a company logo; however, it will display by default a variety of status messages.

Management Ports

An RJ45F Ethernet port is used connect the *T*media unit to the network so that a computer may interrogate the host processor and the main CPU. This port is used to initially assign an IP address to the *T*media unit and to debug the system.

An RJ45F connector for serial communications with a computer running terminal emulation software can be used similarly as with the Ethernet port for the same functionality.

A USB 2.0 port is provided for use on the TMG3200 unit. This port communicates directly with the Linux onboard CPU and can be used to attach peripheral devices controlled by the Linux host.

Power LED

The power LED is used to indicate whether the *T*media unit is powered.

- Solid Green: Unit is powered
- Off: Unit is not powered

Reset Switch

The reset switch has two functions:

- Momentarily pressed: System reset and restart
- Press and hold, 5 seconds: System shutdown

Function Switch

The function switch is used to select between various configured menu options that in turn will cause the status window to display various messages.

3.3 Rear View: Connectors and Power Switch

All connections to the PSTN and VoIP networks as well as the *T*media control network are located at the rear of each of the *T*media units.

When viewed from the rear, from left to right:

- TDM module, as options:
  - 16 RJ45F connectors (T1/E1/J1)
  - 2, 3 or 4 SCSI connectors (T1/E1/J1)
  - 3 sets of dual BNC female connectors (DS3)
  - 2 sets of optical connectors (OC3/STM-1 with APS), or
  - 2 sets of electrical connectors (OC3/STM-1 with APS)
- Dual RJ45F connectors (*T*media TMS1600 Switch ports)
- Dual RJ45F connectors (100/1000 Base-T VoIP ports)
- Dual RJ45F connectors (100/1000 Base-T control ports)
- AC or DC power connection
- ON/OFF power switch

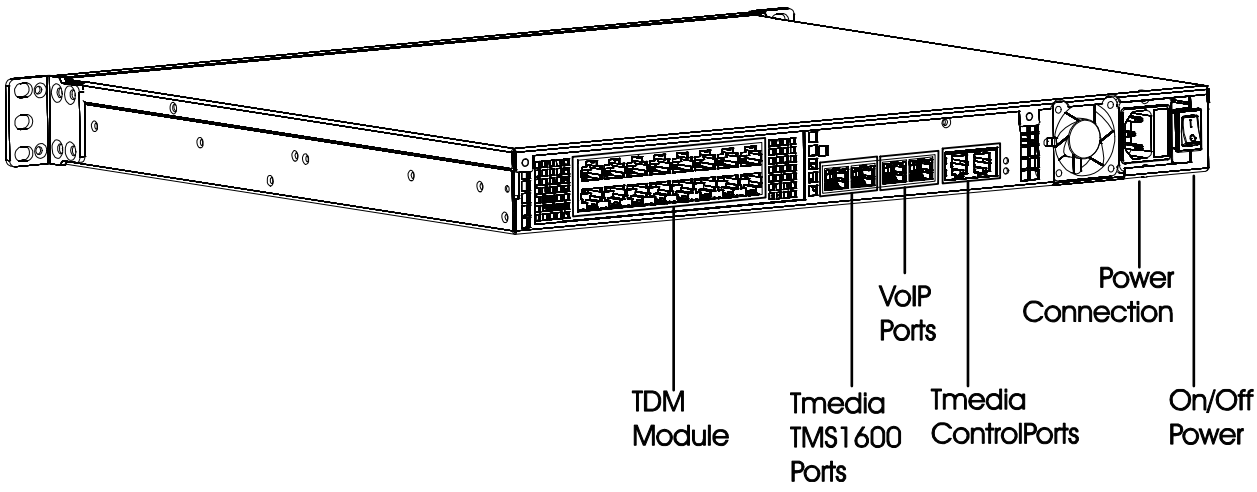


Figure 3.2 *T*media Rear View

PSTN Network Connectors: RJ45F (T1/E1/J1)

16 ports are available on the module for connection to E1, T1, or J1 lines. The base option of this module for TMP6400 and TMG3200 is shipped with four of the 16 ports activated. Purchased software activates the remaining 12 ports in groups of four.

PSTN Network Connectors: SCSI (T1/E1/J1)

SCSI ports are available on the module for connection to T1, E1, or J1 lines via an external patch panel. This module is for the TMP6400 and TMG3200 and is shipped with 2, 3, or 4 SCSI ports for connection to respectively 32, 48, or 64 T1/E1/J1 lines.

PSTN Network Connectors: Dual BNC (DS3)

Three sets of dual BNC female connectors are available on the module for connection to DS3 lines. The base option of this module for the TMP6400 and TMG3200 is shipped with one set of the three sets activated. Purchased software activates additional ports.

PSTN Network Connectors: OC3/STM-1

Two sets of electrical or optical ports are available on the module for connection to OC3/STM-1 optical lines, where one line is used for automatic protection switching. This module for the TMP6400 and TMG3200 is shipped with either an optical or an electrical interface.

*T*media TMS1600 Switch Ports

Provided only on the TMP6400, one set of redundant RJ45F connectors are used for connection of the unit to one or two TMS1600 Switches.

VoIP Network Ports

One set of dual RJ45F GigE ports are provided for connection between the TMP6400 or the TMG3200, and the VoIP network.

*T*media Control Ports

Found only on the TMP6400 and the TMS1600 units, one set of redundant RJ45F GigE ports are provided for connection between the *T*media units and the *T*oolpack API control network.

Power Options

*T*media units are either powered by AC or DC supply.

- AC Power: The *T*media unit is furnished with a 3-pronged AC receptacle for connection to an AC power cord.
- DC Power: The *T*media unit is furnished with a 3-screw DC terminal block for connection to positive (+), negative (-), and Ground.

On/Off Power Switch.

Used to turn power on or off to the *T*media unit

3.4 Plug-In Modules

VoIP Plug-In Module

VoIP plug-in modules are available based on the number of simultaneous VoIP channels supported.

Up to 4 VoIP plug-in modules may be installed on a single *T*media unit, allowing for up to 2,048 universal VoIP channels, or any combination to specifically match your requirement.

The VoIP plug-in module is available in four different channel capacity configurations, as tabulated below:

VoIP Plug-In Modules: Channel Capacities											
Part Number	Universal Codecs				Wireline Codecs				Wireless Codecs		
	G.711	G.723.1	G.726	G.729ab	G.728	G.729eg	iLBC	T.38	AMR	GSM-FR/ GSM-EFR	EVRC/ QCELP
TM-VOIP-1	404	128	216	154	66	84	84	100	84	84	60
TM-VOIP-2	808	256	432	308	132	168	168	200	168	168	120
TM-VOIP-3	1212	384	648	462	198	252	252	300	252	252	180
TM-VOIP-4	1616	512	864	616	264	336	336	400	336	336	240
• G.168-128 ms on all channels simultaneously • In-band DTMF, RFC 2833 and SIP INFO						• VAD, CNG, volume control • Adaptive and fixed jitter buffer					

Each *T*media unit can be retrofitted in the field with any combination of 1, 2, 3, or 4 VoIP plug-in modules.

IVR Plug-In Module

The *T*media IVR plug-in modules are offered in various configurations that support an increasing number of IVR channels. These IVR channels perform tone detection or generation, audio file playback, audio recording, or handling the participants of a conference call.

Each *T*media unit can be retrofitted with a single IVR plug-in module.

The IVR plug-in module is available in four channel capacity configurations as follows:

- TM-IVR-128
  - Software upgradeable in 128 channel segments. Three software upgrades are required to reach a 512 channel capacity.
- TM-IVR-1024
- TM-IVR-1536
- TM-IVR-2048

TDM Plug-In Modules

The TDM plug-in modules are available in three different interface configurations as follows:

T1/E1/J1

- TM-TDM-4: Furnished with 16 T1/E1/J1 connectors. First 4 ports are active.
  - Software upgradeable in 4 port segments. Three software upgrades are required to activate ports 5-16.
- TM-TDM-32: Furnished with 2 SCSI ports for connection to 32 T1/E1/J1 lines via an external patch panel.
- TM-TDM-48: Furnished with 3 SCSI ports for connection to 48 T1/E1/J1 lines via an external patch panel.
- TM-TDM-64: Furnished with 4 SCSI ports for connection to 64 T1/E1/J1 lines via an external patch panel.

DS3

- TM-DS3-1: Furnished with 3 sets of dual BNC connectors. First set is active.
- Software upgradeable in 1 set segments. Two software upgrades are required to activate all three sets.
- Includes 2 x T1/E1/J1 for separate signaling or BITS synchronization.

OC3/STM-1

- TM-STM-1: Furnished with two sets of electrical or optical ports for connection to OC3/STM-1 lines. The second physical interface is used for automatic protection switching.
- Includes 2 x T1/E1/J1 for separate signaling or BITS synchronization.

Each *T*media unit can be retrofitted in the field with any TDM plug-in module.

Chapter 4 Software Architecture

TelcoBridges' software architecture has been designed from the ground up to deliver *T*media system reliability by creating a software platform that allows all the components of the *T*oolpack API to be distributed across several machines in order to share the work load, and to duplicate data and applications so that no single failure will cause an interruption of service.

This chapter presents the elements of *T*oolpack and describes the role that they each play in the successful operation of a *T*media telecom solution.

4.1 Software Application Building Blocks

TelcoBridges' *T*oolpack ™ is a software platform upon which the *T*media TMP6400, TMG3200, and TMS1600 Switch are configured and managed. *T*oolpack is comprised of a series of modular applications designed to carry out specific functions all contributing to the effective and efficient operation of a telecom solution.

*T*oolpack, shown below, is comprised of the following major building blocks:

- *T*oolpack OAM&P
- *T*oolpack Engine Interface
- Customer Applications and TelcoBridges Customizable Classes
- *T*oolpack C++ API
- *T*oolpack Engine
- *T*oolpack System and HA Manager
- TB-StreamServer
- Fax Server

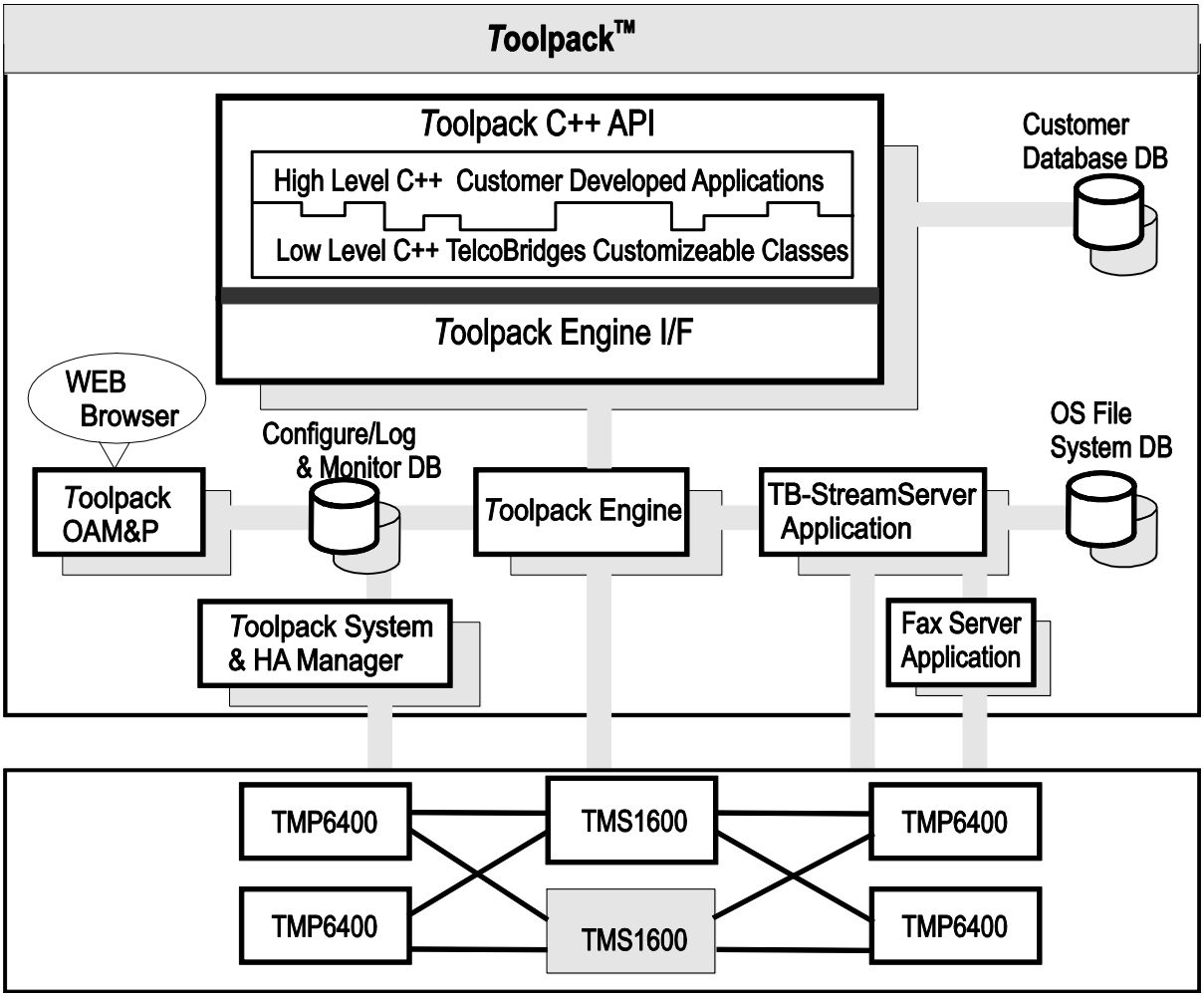


Figure 4.1: Software Architecture Buildings Blocks

In addition to *T*oolpack's applications, a number of databases are required for the storage and retrieval of data. They are:

- Configuration, Logging, and Monitoring Database
- Optional Customer Information Database. Provided by the developer. Not always required; based on the application
- Optional OS File System Database for prompts, files, or voice recordings. Provided by the developer. Not always required; based on the application

*T*oolpack OAM&P

The *T*oolpack OAM&P application is accessed via a Web-based interface by the developer in order to configure the *T*media units and their access to hardware and network resources. It is used as well to manage all *T*oolpack system applications over multiple application servers. Using OAM&P, the developer defines the physical interfaces, the signaling interfaces, and the classification of functions into logical network access points. OAM&P configures network access points with signaling types, such as: SIP, SS7, ISDN, and CAS. This allows for a unified and simpler assignment approach of network resources. In addition, because a major portion of the resources are dynamic, most of them do not need to be programmed by the OAM&P application.

In a network, synchronization is an important key to fluid operation. The OAM&P application defines from which TDM or BITS interface a clocking signal is to be used. A number of choices can be configured from a selection of TMP6400s and TMG3200s to provide a pool from which the best clocking signal is used. For IP only environments, the clock source can be the on-board oscillator.

The architecture of the *T*oolpack applications is designed to be distributed across multiple machines, in order to share loading as well as to incorporate redundancy; furthermore, the OAM&P defines on which server any given application will run, as well as defines which server runs the active application as opposed to the standby. The addition of a redundant server and the switching from active to standby is accomplished without any interruption of service.

> Upgrades to software can be loaded onto servers and switched into service without any suspension of service.

Key Features:

- Easy-to-use web-based tool
- Fully flexible control of system resource configuration
- Redundant backup configuration
- Live software update
- Live configuration changes
- Live system scalability

Configuration, Logging, and Monitoring Database

Once the initial configuration has been completed by the developer using OAM&P, its settings are stored in the *T*oolpack Configuration, Logging and Monitoring database, in a TelcoBridges predefined database format. When the database is updated with new information, it in turn sends an update-trigger message to the *T*oolpack System and HA Manager application, *T*oolpack engine, TB-StreamServer, and customer applications

Key Features:

- Redundant backup configuration
- Storage of all provisioning configuration
- On-the-fly storage of configuration settings from the OAM&P application
- On-the-fly download of configuration settings to the *T*media units

*T*oolpack System and HA Manager Application

The *T*oolpack System and HA Manager offers a multifaceted set of features for the TelcoBridges *T*media platform. A main focus of this application is to manage system redundancy in the event of failure. If one of the *T*oolpack applications should fail, uninterrupted service recovery is achieved by switching application functions to a standby server running a standby application. If a communication path between the *T*oolpack Engine and a *T*media unit is lost, a redundant path is automatically selected. In addition to a redundant communication path, the resources of one *T*media unit can be made available to another *T*media unit. For example, if the SS7 protocol stacks on a TMP6400 were to fail, then the SS7 signaling stack of another TMP6400 could be used to handle the calls. With an eye on failure recovery, the *T*oolpack System and HA Manager application enables the *T*media network to continue to operate without compromising operations

Changes to system configuration usually are a regular occurrence, and need to be made in such a way that new changes become effective immediately without having to stop or restart a *T*media system. The System and HA Manager makes this a painless process. Configuration changes made to the *T*media system from the OAM&P application are retrieved without system interruption and downloaded to the *T*media system. Changes become effective without a single interruption. If in fact, it does become necessary to reload an entire configuration to a *T*media unit, this is managed by the System and HA Manager.

Key Features:

- Manages resource availability
- Decides upon standby takeover in cases of failure
- Reallocates available resources where they are most needed
- Switches to the standby *T*media TMS1600 Switch
- Manages clock fallback and recovery

*T*oolpack Engine

The *T*oolpack Engine is the central core for the assignment and control of resources on the *T*media platform. Serving as a relaying point between the *T*oolpack Engine Interface, the TB-StreamServer, and the Configuration, Logging, and Monitoring database, the *T*oolpack Engine receives application requests from the *T*oolpack Engine Interface and transmits them to the appropriate *T*media unit. In addition, the *T*oolpack Engine receives requests from the *T*media units, which it in turn transmits to the *T*oolpack Engine Interface.

For example, for an incoming call on a TMP6400, it sends a message to the *T*oolpack Engine for processing instructions. The *T*oolpack Engine relays the request to the *T*oolpack Engine Interface for processing instructions. Once the instructions are received, the *T*oolpack Engine assigns the call to the appropriate resource. Whether this is a bridge to another line, or a connection to the TB-StreamServer, the *T*oolpack Engine manages the assignment.

Key Features:

- Assignment and control of resources
- Interfaces between the *T*media units and the *T*oolpack API
- Interprets *T*media unit requests and relays them to the *T*oolpack API
- Transmits instructions to the *T*media units

*T*oolpack Engine Interface

The *T*oolpack Engine Interface bridges the C++ functions from the applications created by the developer with the *T*oolpack Engine. In addition, the *T*oolpack Engine Interface is responsible for the discovery of the active *T*oolpack engine with which it communicates. If the active *T*oolpack Engine application fails, then the *T*oolpack Engine Interface will switch its communications over to the standby *T*oolpack Engine.

Key Features:

- Automatic *T*oolpack Engine detection
- Automatic resynchronization of current call legs and associated media
- Provides automatic HA resynchronization capabilities in case of application failure/restart
- Automatic load sharing between *T*oolpack Engines
- Thread pooling and call context serialization
    - Allows for a more efficient use of CPU resources (threads, semaphores, etc)
    - Synchronous operations on one call leg without affecting other call legs

TB-StreamServer Application

The TB-StreamServer application receives processing instructions from the *T*oolpack Engine in order to know whether a call requires that media be streamed out to the network or to perhaps record incoming media. The TB-StreamServer application, once it has received its processing instructions, will access its file system to retrieve the media necessary for a call. Once the media is accessed, the TB-StreamServer streams on an assigned path out to the *T*media unit. In order to record media, the *T*media unit sends a record request to the TB-StreamServer and the media is written to a file.

In addition, the TB-StreamServer is responsible for the transport of fax transmissions between a *T*media unit and the fax server. Received faxes are converted by the fax server into a graphical TIFF file for storage on the TB-StreamServer.

Key Features:

- Automatic streaming and recording media for playback
- Automatic treatment of fax transmissions
- Simple configurations of the TB-StreamServer via the OAM&P application

*T*oolpack Customer Applications and TelcoBridges Customizable Classes

The *T*oolpack API is designed to simplify the work of the developer by providing fully operational TelcoBridges C++ classes. These classes define the manner in which network solutions will operate and the characteristics that they will assume. Should these classes not quite match with the requirements of the developer, customer applications can be developed that borrow upon the main TelcoBridges classes but customize specific operations to meet the developer's. Because the entire *T*oolpack classes are completely open to the developer, based upon their needs, they can even modify the base TelcoBridges classes. Whether TelcoBridges classes are used as is, or they are customized, or instead customized classes are built by the developer, the platform is open and the decision is left up to developer to choose the path that best fits their needs.

TelcoBridges' predefined *T*oolpack classes are listed as follows:

CAF Application: Reference Telephony Application

This ready-to-use application builds upon the other pre-developed C++ modules to implement basic any-to-any VoIP and TDM communications. It handles incoming voice calls—whether on VoIP or TDM links—and bridges them together based on a pre-configured routing table.

- Voice transcoding, A-law to mu-law conversion, and echo cancellation are automatically handled based on network interface configuration.
- Network signaling is transparently handled, implementing SIP signaling on VoIP network interfaces, and SS7 and/or ISDN signaling on TDM interfaces.
- A basic call routing table associating network addresses with network access points (unique identifiers used internally to designate separate networks, whether VoIP or TDM) is provided. For example, the routing table entry for the TDM network address +1 450 xxx xxxx, may be associated with the SIP domain "telcobridges.com", or with the SS7 NAP. The Call Bridging module uses the network access point found in the routing table entry to route outgoing calls.
- The routing table database is configured using the Web-Based GUI, or configuration files.

CAF Module: Web-Based GUI

- This is an HTML application which is served by a web server application.
- The module provides an easy-to-use GUI to configure hardware, physical interfaces, protocol stacks, and call routing tables.
- This module is developed using Ruby on Rails. It is customizable and provides the seed to create the system's OAM&P GUI.

Note: Developers with their own web-based GUI can decide to operate directly with the OAM&P database

CAF Class: Call Bridging

- Connects incoming and outgoing call legs together while managing intermediate call states such as "alerting", "trying", "ringing", etc.
- The functionality is protocol and media agnostic (i.e. connects any SS7, ISDN or SIP calls together and automatically handles any transcoding or A-law to mu-law conversion).

CAF Class: Call Leg Handling

- Using this module, it is easy to directly manage individual call leg states independently of their type, whether VoIP or TDM, to customize behavior in response to specific events.
- For example, an outgoing call can be created using this class, or an incoming call may be answered, a call may be terminated, or tones may be suppressed or generated in only one call direction, the call leg may be recorded or a prompt may be played, and so on.

CAF Class: Call Routing

- This module implements a means to look up a route in a database based on outgoing call identifiers such as a telephone number prefix or SIP domain name.
- It returns the network access point which is used by the call bridging module, or other code, to establish the outgoing call leg and bridge it with the incoming call leg.

CAF Class: IVR

- This module enables IVR functions on any VoIP or TDM call leg.
- The functions implemented include actions such as playing a prompt, collecting DTMF digits, returning strings, detecting escape sequences, etc.
- The code transparently controls TelcoBridges' TB-StreamServer application to play or record an audio file.

CAF Class: IVR Menu

- Implements an IVR menu in which prompts are played offering different menu choices.
- The module handles events such as DTMF string capture, on-hook, timeout, etc. The event handling behavior is customizable.
- The module is easily cascaded to develop sophisticated IVR call flows matching specific requirements.

CAF Class: Ringback Tones

- This module is available to customize ringback tones heard by callers based on a database lookup result.
- Inherits the functionality of CAF-Class IVR and transparently controls TelcoBridges' TB-StreamServer application to play the appropriate audio file.

CAF Class: Voicemail

- Implements the main functionalities needed to build a voicemail application.
- Prompt playing, DTMF digit collection, database password lookup, voice mailbox administration, and message playback are included in this module which can be easily adapted to individual requirements.
- This module builds upon and inherits the capabilities of the IVR and database access CAF classes.

CAF Class: Database Access

- This is a general purpose C++ module providing access to any ODBC compliant database, such as: ODBC, MySQL, SQLite, Oracle, and more. Contact TelcoBridges for further information.
- It can be easily customized to create call detail records with fields containing information for calling numbers, called numbers, start date and time, tariff code, etc.

CAF Class: Com

This class provides a method for two applications to create services that will communicate with each other and exchange messages.

CAF Class: Log

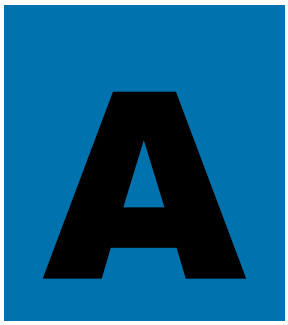
This is a logging facility that writes to XML or text files using a per-module configurable trace level. It manages the file rotation and is used by all of the CAF classes. It can be customized by the developer for the implementation of traces.

CAF Class: CLI

This is a command line interface tool that provides the developer with a convenient shell-based interface that displays application statuses, application logs, and allows for the entry of commands in order to query the applications. This tool is supported on all OS platforms, such as: Windows, Linux, and Solaris.

Customer Applications

This high-level portion of the *T*oolpack C++ API is designed to allow the system developer to customize the CAF classes. Since the CAF classes are generic classes geared to cover all aspects of telecom applications, the system developer can modify the CAF classes to suit their needs.



Appendix A List of Acronymns

2/2.5/3G	Second, Second and a Half, Third Generation
AC	Alternating Current
AMR	Adaptive Multi-Rate
API	Application Programming Interface
ASR	Automatic Speech Recognition
BITS	Building Integrated Timing Supply
BNC	Bayonet Neill-Concelman
CAF	Customer Application Framework
CAS	Channel Associated Signaling
CLI	Command Line Interface
CNG	Comfort Noise Generation
CPU	Central Processing Unit
DB	Database
DC	Direct Current
DS3	Digital Signal Level 3
DTMF	Dual Tone Multi-Frequency
E1	E-Carrier Level 1
EVRC	Enhanced Variable Rate Codec
GB	Gigabyte
GigE	Gigabit Ethernet
GSM-EFR	Global System For Mobile Communications, Enhanced Full Rate Codec
GSM-FR	Global System For Mobile Communications, Full Rate Codec
GUI	Graphical User Interface
HA	High Availability
HTML	Hypertext Markup Language
HVAC	Heating Ventilation and Air Conditioning
I/F	Interface
iLBC	Internet Low Bitrate Codec
IP	Internet Protocol
IP-PBX	Internet Protocol Private Branch Exchange
ISDN	Integrated Services Digital Network

ISUP	ISDN User Part
IVR	Interactive Voice Response
J1	J Carrier Level 1
LED	Light Emitting Diode
MB	Megabyte
MHz	Megahertz
ms	millisecond
MTP2/3	Message Transfer Part 2/3
NAP	Network Access Point
OAM&P	Operations, Administration, Maintenance, & Provisioning
OC3	Optical Carrier Level 3
ODBC	Open Database Connectivity
OS	Operating System
OSS	Operations Support System
PIN	Personal Identification Number
PRBT	Personalized Ringback Tone
PSTN	Public Switched Telephone Network
QCELP	Qualcomm Code Excited Linear Prediction
RAM	Random Access Memory
RJ45F	Registered Jack 45 Female
SCCP	Signaling Connection and Control Part
SCSI	Small Computer System Interface
SDP	Session Description Protocol
SIP	Session Initiation Protocol
SIP-T	Session Initiation Protocol for Telephones
SMS	Short Message Service
SS7	Signaling System Number 7
STM-1	Synchronous Transport Module Level 1
T1	Transmission Level 1
TCAP	Transaction Capabilities Application Part
TDM	Time Division Multiplexing
TIFF	Tagged Image File Format
TTS	Text To Speech
USB	Universal Serial Bus
VAD	Voice Activity Detection
VoIP	Voice Over Internet Protocol
WiMAX	Worldwide Interoperability for Microwave Access
XML	Extensible Markup Language